



Until the End of Time: Mind, Matter, and Our Search for Meaning in an Evolving Universe

Brian Greene

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Instant New York Times Best-seller

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From the world-renowned physicist and best-selling author of *The Elegant Universe* comes a captivating exploration of deep time and humanity's search for purpose.

Until the End of Time is Brian Greene's breathtaking new exploration of the cosmos and our quest to find meaning in the face of this vast expanse. Greene takes us on a journey from the big bang to the end of time, exploring how lasting structures formed, how life and mind emerged, and how we grapple with our existence through narrative, myth, religion, creative expression, science, the quest for truth, and a deep longing for the eternal. From particles to planets, consciousness to creativity, matter to meaning—Brian Greene allows us all to grasp and appreciate our fleeting but utterly exquisite moment in the cosmos.

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BlackOxford says

“I Think That I Think, Therefore I Think That I Am”

- Ambrose Bierce

I am reminded not only of Ambrose Bierce's aphorism above (which is mentioned by Greene) but also of Ludwig Wittgenstein's comment upon visiting a bridge under construction in the North of England. Hearing the almost incomprehensible Scots and Geordie banter among the workers, he remarked 'Isn't it amazing what people who talk like that can do?'

It is indeed almost miraculous what human beings can do with language. But many believe they can use language not just to build bridges but to tell the rest of us about ultimate reality. Descartes used language to prove the reality of his own existence in his famous *Cogito Ergo Sum*. Before him, Anselm of Canterbury used language to demonstrate what he thought was the reality of the divine by simply defining God as 'that of which nothing greater can be thought'. Brian Green thinks we'll eventually be able to explain everything about reality - ourselves and God included - if we just tell enough stories about it.

Greene considers himself a reformed reductionist - that is, someone who used to believe in one fundamental story about reality. He now believes that the scientific stories by chemists, physicists, and biologists are not the only stories that are meaningful. "*There are many ways of understanding the world*," he says. A non-scientist who reads novels, biographies, and poetry can only agree. What matters for him is that the stories that are told are increasingly consistent and coherent with each other. It is unclear how he proposes to compare, say, *Finnegans Wake* and the second law of Thermodynamics for consistency and coherence. Nevertheless, this is his measure not just of scientific progress but also of human cultural development.

The story he likes best because of its inclusiveness is that of gravity and entropy. The way he tells it, gravity is the force which sparked the entire cosmos in the Big Bang. A small and statistically unlikely perturbation in the microscopic ball of proto-energy caused that extremely low entropy ball to expand in a billionth of a second to a universe billions of light years in size. The photons and other nuclear material contained in the original singularity are spread through newly existing high-entropy space virtually instantaneously. Ever since, gravity and entropy have been in a continuous battle, driving not just the creation and destruction of galaxies, stars and planets, but also the life that has emerged on the latter, including us. We are little islands of relatively low entropy, contributing the best we can to the eventual heat-death of the universe. Even without our industrial level carbon footprints, we can't help but turn high quality energy into useless background radiation.

Great story. But here's a layman's problem: Gravity hasn't been considered a force, much less the originary creative force, since Einstein formulated his theory of relativity. Gravity, as I understand it, is a perturbation of space-time. So when Greene states "According to the general theory of relativity, the gravitational force can be repulsive," I start to get seriously confused. Did space-time exist before the Big Bang? If not, how can gravity be its motivating factor?

And Greene goes on to explain that critical moment of orgasmic cosmic release, "*When a tiny speck of space finally makes the statistically unlikely leap to low entropy, repulsive gravity jumps into action and propels it into a rapidly expanding universe—the Big Bang*," I am left speechless as he treats this non-thing of entropy as a substance that colonises the newly formed world. Entropy is not a force or a substance but a descriptive condition. Having it do cosmic battle with another non-force/non-substance like gravity seems to me to be pushing a metaphor beyond its design tolerances.

Is he condescending to popular usage or just being sloppy? In any case, I'd really like to understand how a tiny nick in the constitution of the speck of initial energy could cause an apparent violation of quantum laws

of movement wherein light and atomic particles can move millions of times faster than photons (not to mention matter) can travel. His cavalier treatment of time and alternative entropic 'trials' before the Big Bang seem to me just hand-waving. I felt like an eager adolescent searching for the dirty bits in *Lady Chatterley's Lover*. But just when things start to get really hot, Greene changes the subject.

According to this story, if the universe is expanding forever, entropy is the winner of the cosmic game and the universe is effectively eternal. On the other hand, if there is an ultimate cosmic collapse, gravity triumphs. But in the latter case, there would be a limit to gravity's reign, just as there is in the formation of stars. When densities increase sufficiently, nuclear fusion kicks in, and gravity gets checked and the gravity/entropy "two-step" is ignited anew. So the whole process would start again - and crucially not from the same place as the Big Bang. But this too implies eternity.

Eternity bothers me because it points to something beyond language. It's an indication, like the word 'God', of the ultimate inadequacy of language to describe reality ('reality' is also one of those words). I am encouraged that Greene doesn't think that a single scientific or mathematical story is sufficient and that we must 'sweep in' as many accounts of existence as we can, including non-scientific ones. But I despair when someone like Greene thinks that this will improve our understanding of reality. It may help us to stop persecuting each other; it will certainly result in faster, more powerful, and more varied machines and products of all sorts. But it will get us no closer to reality, to that which is permanently beyond language.

Jen says

Are you the type of person who gets teary eyed from thinking about a cosmos studded with stars that are constantly engaged in thermonuclear bickering with a relentless gravitational crush? Well, hold on, I've got something in my eye. Have you ever, after deliriously consuming grandma's confections with your scalded bare hands, saw a remaining dollop of sugary goodness sitting squarely in the middle of the pie pan, the edges of which, if taken as points, all seemed perfectly equidistant from the remains? If you're anything like me, that moment marked for you a turning point, in which the Schwarzschild Radius ceased to be a mere theoretical construct, and came to inform your taste in apple pie henceforth.

So, first things first. There's an obvious comparison to be made here for anyone that's read *The Denial of Death* by Ernest Becker, and if you have, imagine that this book is basically that, but focused less on psychology, and more on The Second Law of Thermodynamics, and how life staves off entropic degradation on the molecular level. If you're not familiar with that book, or if you think I'm invoking Aleister Crowley; let me summarize. Becker argued that much of the striving we do in life is motivated by the dichotomy between our ability to reach towards the divine while being creatures who go back into the dirt. This cognitive dissonance, he reasoned, causes us to deploy our grandest creative strategies in the service of combating it. In a similar fashion, this book covers key scientific insights in our ongoing quest to discover our place in the cosmos, and reconcile the knowledge of not only our own impermanence, but that of the universe as well.

Here's some things you'll learn about: The salience of entropy in our lives (The aforementioned Second Law, not to be confused with a Crowley injunction). Evolution by natural selection. Speculation on the antecedents of DNA. The central importance of Redox Reactions in metabolizing pie, and Black Holes. After this, the book necessarily becomes more philosophical in nature, covering topics of epistemology, language, consciousness, free will, religion, and finally our *raison d'être*. Some people may be put off by this move into the speculative and poetic, and if you're looking for a book that's purely grounded in scientific reasoning, look elsewhere.

For me, as a person who, while not religious, does experience awe in the way that Einstein captured in his more deistic scribbles, I found it highly enjoyable, and would recommend it to anyone with a similar

disposition. Greene, as usual, writes in a witty and accessible style, and adopts an appropriately humble and open minded position when it comes to the big questions.

Let's close this review out with a couple of quotes.

"If you wish to make an apple pie from scratch, you must first invent the universe." — Carl Sagan.

"A knowledge of the existence of something we cannot penetrate, of the manifestations of the profoundest reason and the most radiant beauty - it is this knowledge and this emotion that constitute the truly religious attitude; in this sense, and in this alone, I am a deeply religious man." — Albert Einstein.

Slip into sugar induced torpor with this book!

Jenna says

"In the search for value and purpose, the only insights of relevance, the only answers of significance, are those of our own making. In the end, during our brief moment in the sun, we are tasked with the noble charge of finding our own meaning.

Well, this was a bit of a train wreck. It started out interesting. I was really into the first 3 chapters, especially the third, "Origins and Entropy". After that, as another reviewer ironically noted, the book itself appears to suffer an increase in entropy.

Brian Greene is a theoretical physicist but in this book he veers off into philosophy and linguistics and sociology and other sciences. 'Round and around we go. It was all over the place. It seemed to me that Mr. Greene decided to write a book about the future of the universe using his speciality of physics, but then found he had only enough material for a few chapters. Therefore, perhaps at the insistence of his publisher, he decided to add more chapters by discussing other scientific fields he has read up on.

And he lost me. Perhaps it was simply that I was really wanting some cold hard facts, something that would require my brain to let go of every other thought and just focus on what I was reading. Something that would give my brain some structure for a time. Some people escape through reading with books that don't require any or much thought. That doesn't work for me. In order to escape reality (and who doesn't want to escape a little during a pandemic?!) I need a book that demands total attention. A book that engages my grey matter sufficiently that I let go of all my present worries. Books on this subject are often my ticket to escape. Unfortunately, this particular one just didn't do it.

It meandered and so did my thoughts. Though it sometimes talked of complex physics, it more often talked about things that didn't require my full attention.

I do appreciate that it doesn't require a background in complex mathematics as some physics books do. It's easy to understand, though I found there to be far too many explanations and examples for just about everything. I got it the first time, I kept thinking; now the additional examples just gives my brain cells room to think (obsess!) about teeny tiny viruses.

4-5 stars for the first 3 chapters. 2 for the filler chapters. 5 stars for the next to last chapter and 3 for the last. I'm no mathematician but I'll just do a rough estimate and average it out to 3 stars.

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